



### Question 1 (9 marks)

A sample of a school community are surveyed on how they travel to school. The table below shows the survey results.



#### Question 1a (2 marks)

**Write down** the missing values in the table below.

	Bus	Train	Car	Total
Students	66	8	20	<input type="text"/>
Teachers	12	<input type="text"/>	15	56
Total	78	37	35	<input type="text"/>

One person is selected at random from the sample group.



Scroll down to continue



1 (9 marks)

Question 1a

Question 1b

Question 1c

Question 1d



2 (7 marks)



3 (8 marks)



4 (12 marks)



5 (10 marks)



6 (22 marks)



7 (32 marks)



### Question 1b (2 marks)

**Determine** the probability that the person selected is a student who does not travel by train.

B I

↶ ↷

U x<sub>2</sub> x<sup>2</sup>

≡ ≡ ≡

Ω Σ

Styles



### Question 1c (1 mark)

Given that the person selected is a teacher, **write down** the probability that this teacher travels by car.

B I

↶ ↷

U x<sub>2</sub> x<sup>2</sup>

≡ ≡ ≡

Ω Σ

Styles



### Question 1d (4 marks)

Given that **three** teachers are selected at random from the sample group, **find** the probability

1 (9 marks)	⌵
Question 1a	
Question 1b	
Question 1c	
Question 1d	
2 (7 marks)	⌵
3 (8 marks)	⌵
4 (12 marks)	⌵
5 (10 marks)	⌵
6 (22 marks)	⌵
7 (32 marks)	⌵

- 1 (9 marks) ⌵
  - Question 1a
  - Question 1b
  - Question 1c
  - Question 1d
- 2 (7 marks) ⌵
- 3 (8 marks) ⌵
- 4 (12 marks) ⌵
- 5 (10 marks) ⌵
- 6 (22 marks) ⌵
- 7 (32 marks) ⌵



### Question 1d (4 marks)

Given that **three** teachers are selected at random from the sample group, **find** the probability that exactly **two** of them travel by bus.

**B** ***I*** ↶ ↷ U  $x_2$   $x^2$   $\frac{1}{2}$   $\frac{3}{4}$   $\Omega$   $\Sigma$  Styles 📱





## Question 2 (7 marks)



### Question 2a (2 marks)

$$f(x) = (x - 5)^2$$

$$g(x) = 4(x - 5)^2 - 1$$

The function  $f(x)$  is transformed to  $g(x)$ . **Determine** the transformations that map  $f(x)$  onto  $g(x)$ .

1st transformation

**B** *I*
↶ ↷
U  $x_2$   $x^2$ 
☰ ☲
 $\Omega$   $\Sigma$ 
Styles

2nd transformation

**B** *I*
↶ ↷
U  $x_2$   $x^2$ 
☰ ☲
 $\Omega$   $\Sigma$ 
Styles



1 (9 marks)



2 (7 marks)



Question 2a

Question 2b

Question 2c



3 (8 marks)



4 (12 marks)



5 (10 marks)



6 (22 marks)



7 (32 marks)



Scroll down to continue





Question 2b (3 marks)

$$g(x) = 4(x - 5)^2 - 1$$

**Solve** for  $x$  when  $g(x) = 0$ .

**B**
*I*





U
 $x_2$ 
 $x^2$

$\frac{1}{x}$ 
 $\frac{1}{x^2}$

$\Omega$ 
 $\Sigma$

Styles





Question 2c (2 marks)

Hence, **plot** the range of values of  $x$  that satisfies the inequality  $g(x) < 0$ . Use the draggable items to indicate the solution.

- ☒ 1 (9 marks) ▼
- ☐ 2 (7 marks) ▲
- Question 2a
- Question 2b
- Question 2c
- ☐ 3 (8 marks) ▼
- ☐ 4 (12 marks) ▼
- ☐ 5 (10 marks) ▼
- ☐ 6 (22 marks) ▼
- ☐ 7 (32 marks) ▼



Scroll down to continue



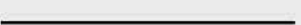
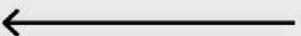
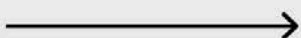


Question 2c (2 marks)

Hence, **plot** the range of values of  $x$  that satisfies the inequality  $g(x) < 0$ . Use the draggable items to indicate the solution.



Draggable items:



1 (9 marks)

2 (7 marks)

Question 2a

Question 2b

Question 2c

3 (8 marks)

4 (12 marks)

5 (10 marks)

6 (22 marks)

7 (32 marks)



Scroll down to continue



Video

Script



🌙 1 (9 marks) ▾

🌙 2 (7 marks) ▾

🌕 3 (8 marks) ▴

Question 3a

Question 3b

Question 3c

Question 3d

🌕 4 (12 marks) ▾

🌕 5 (10 marks) ▾

🌕 6 (22 marks) ▾

🌕 7 (32 marks) ▾



Scroll down to continue










Video

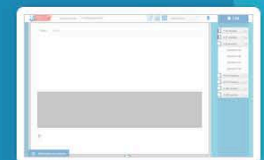
Script

Storage units in the shape of a square-base prism are available to be purchased.

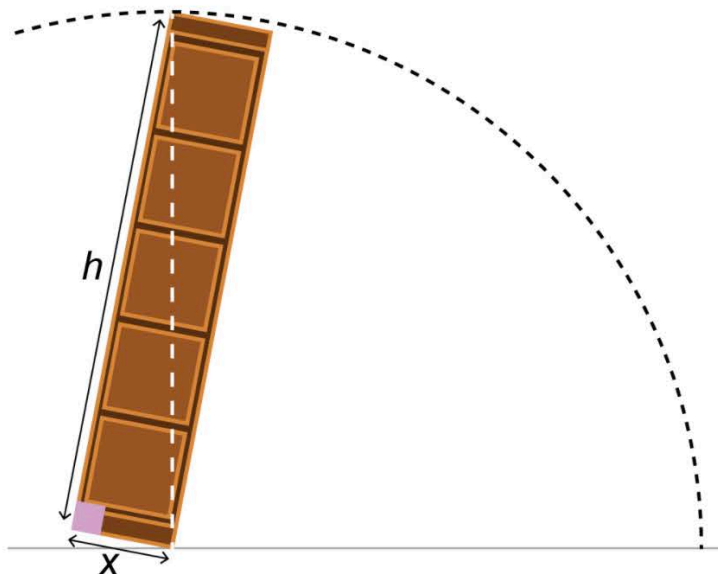
When a storage unit is delivered to the home it is lifted into place.

The dimensions of the storage unit must be chosen carefully otherwise it may not be possible to lift it into place.

- ☒ 1 (9 marks) 
- ☒ 2 (7 marks) 
- ☒ 3 (8 marks) 
- Question 3a
- Question 3b
- Question 3c
- Question 3d
- ☒ 4 (12 marks) 
- ☒ 5 (10 marks) 
- ☒ 6 (22 marks) 
- ☒ 7 (32 marks) 







The diagram above shows a storage unit of height ( $h$ ) cm with a square base of length ( $x$ ) cm.

The room has a ceiling height of 230 cm.

You are selecting a storage unit that can be lifted to the vertical position in the room.

➤ Scroll down to continue



### Question 3a (3 marks)

A storage unit has  $x = 50$  cm and  $h = 225$  cm.

**Show that** it cannot be lifted to the vertical position in the room.

**B**

***I***

$\times_2$

$\times^2$

$\frac{\square}{\square}$

$\div$

$\times$

$\Omega$

$\Sigma$

Styles

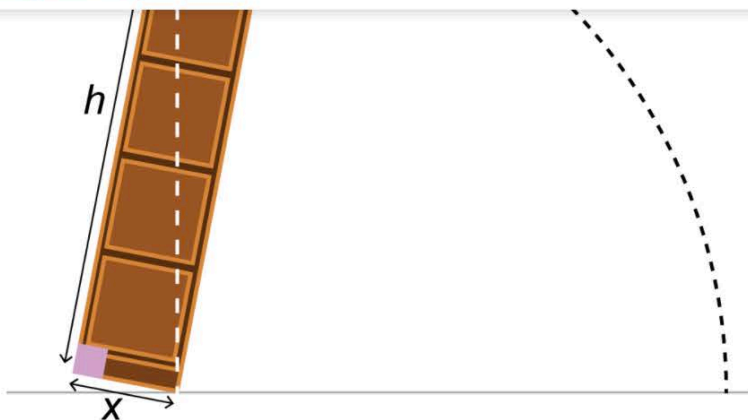


### Question 3b (2 marks)

**Determine** the maximum possible value of  $h$  in terms of  $x$ .

- 1 (9 marks)
- 2 (7 marks)
- 3 (8 marks)
- Question 3a
- Question 3b
- Question 3c
- Question 3d
- 4 (12 marks)
- 5 (10 marks)
- 6 (22 marks)
- 7 (32 marks)





The diagram above shows a storage unit of height ( $h$ ) cm with a square base of length ( $x$ ) cm.

The room has a ceiling height of 230 cm.

You are selecting a storage unit that can be lifted to the vertical position in the room.



### Question 3c (1 mark)

Hence, **determine** the maximum possible value of  $h$  when  $x$  is 50 cm.

B I

← →

U

$\times_2$

$\times^2$


$\frac{1}{x}$

$\frac{1}{x^2}$

$\Omega$

$\Sigma$

Styles





### Question 3d (2 marks)

You chose a storage unit with  $x = 50$  cm and  $h = 220$  cm. **Determine** its volume.

B I

← →

U

$\times_2$

$\times^2$

$\frac{1}{x}$

$\frac{1}{x^2}$

$\Omega$

$\Sigma$

Styles





Scroll down to continue

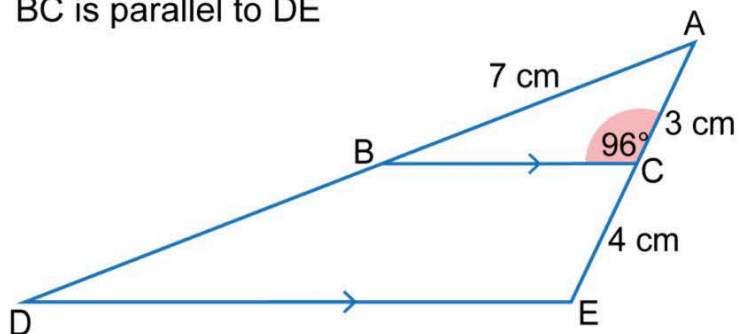
- ☐ 1 (9 marks) ▾
- ☐ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▴
- Question 3a
- Question 3b
- Question 3c
- Question 3d
- ☐ 4 (12 marks) ▾
- ☐ 5 (10 marks) ▾
- ☐ 6 (22 marks) ▾
- ☐ 7 (32 marks) ▾

Question 4a (2 marks)

Diagram not to scale



$\overline{BC}$  is parallel to  $\overline{DE}$



Show that triangle ABC is similar to triangle ADE.

Rich text editor toolbar with options for Bold (B), Italic (I), text color, background color, bulleted list, numbered list, link, unlink, and insert link. Below the toolbar is a large text area for the answer.

- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☐ 4 (12 marks) ▴
- Question 4a
- Question 4b
- Question 4c
- Question 4d
- ☒ 5 (10 marks) ▾
- ☒ 6 (22 marks) ▾
- ☒ 7 (32 marks) ▾

Question 4b (4 marks)

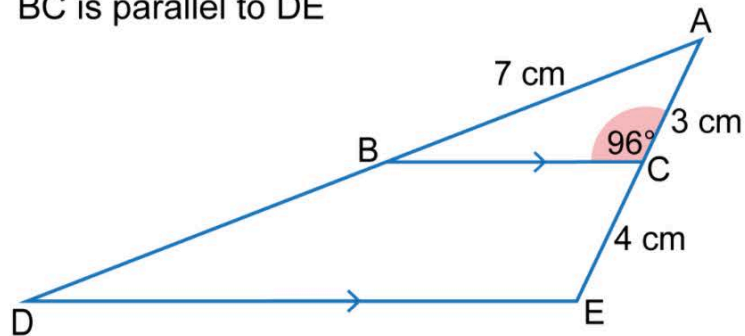
Given that the area of triangle ABC is  $9 \text{ cm}^2$  to the nearest  $\text{cm}^2$ , find the area of trapezium BCED.

Rich text editor toolbar with options for Bold (B), Italic (I), text color, background color, bulleted list, numbered list, link, unlink, and insert link. Below the toolbar is a large text area for the answer.



Diagram not to scale




$\overline{BC}$  is parallel to  $\overline{DE}$



Show that  $\angle ABC$  is  $25^\circ$  to the nearest degree.

**B** *I*  
U  $\times_2$   $\times^2$   $\frac{\square}{\square}$   $\frac{\square}{\square}$   $\Omega$   $\Sigma$

Styles 



Question 4d (3 marks)

Hence, find the length of BE.

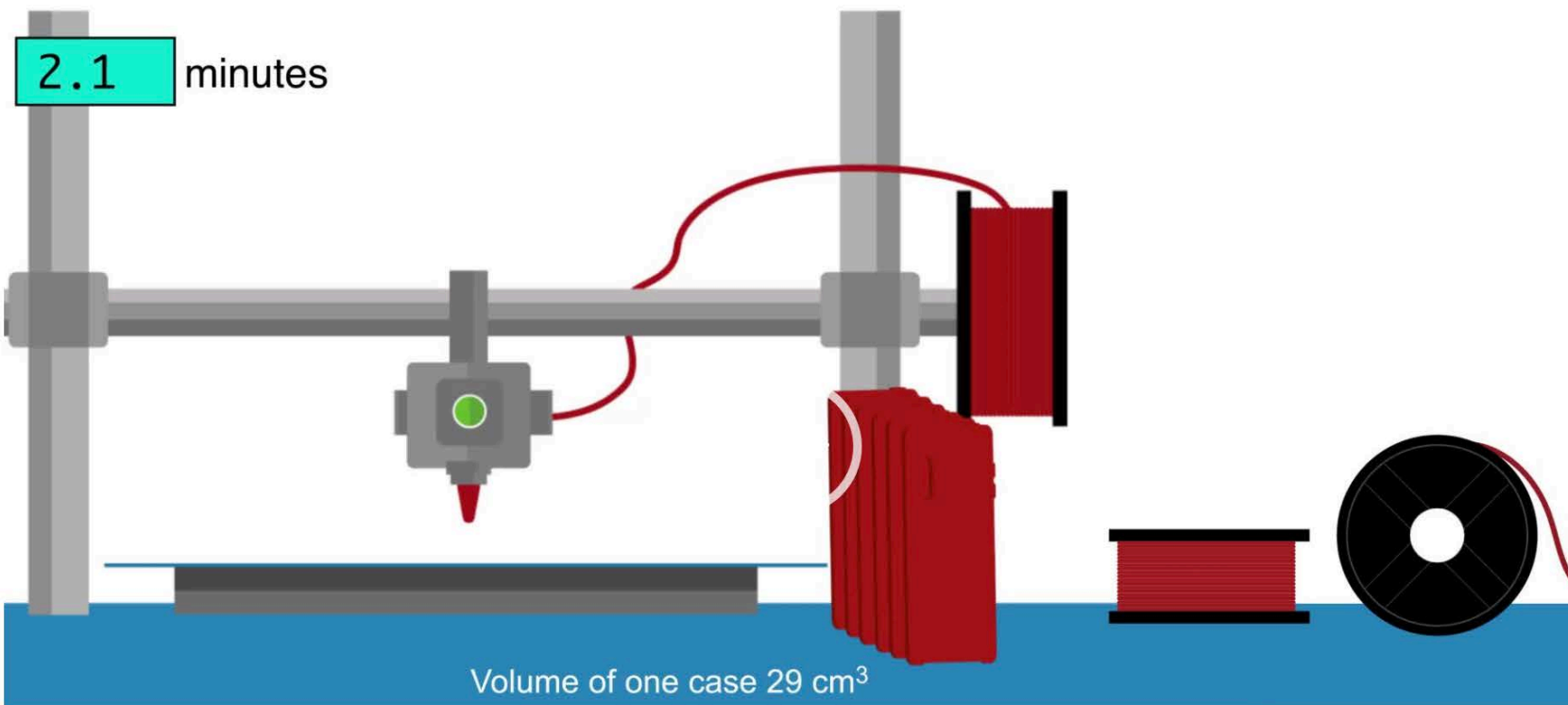
**B** *I*  
U  $\times_2$   $\times^2$   $\frac{\square}{\square}$   $\frac{\square}{\square}$   $\Omega$   $\Sigma$

Styles 

- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☐ 4 (12 marks) ▴
- Question 4a
- Question 4b
- Question 4c
- Question 4d
- ☒ 5 (10 marks) ▾
- ☒ 6 (22 marks) ▾
- ☒ 7 (32 marks) ▾

Question 5 (10 marks)

The animation below shows the three-dimensional (3D) printing of a mobile phone case. The time taken to print a mobile phone case is not constant.



Time taken to print one phone case (minutes)

18.3	18.5	19.1	19.8	19.8	19.9					
------	------	------	------	------	------	--	--	--	--	--

- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☒ 4 (12 marks) ▾
- ☐ 5 (10 marks) ▴

Question 5a

Question 5b

Question 5c

Question 5d

Question 5e

Question 5f

☐ 6 (22 marks) ▾

☐ 7 (32 marks) ▾



Scroll down to continue



One spool of filament



Diameter = 1.75 mm

Mass = 1000 g

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

**Glossary:**

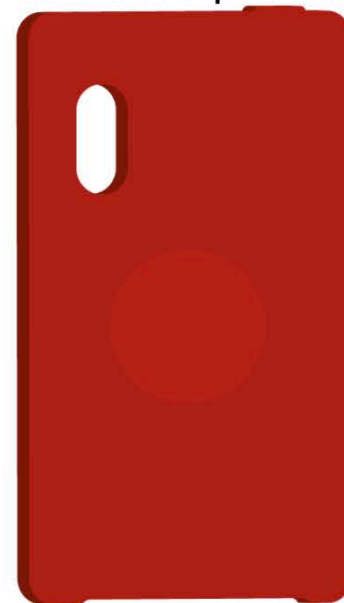
Filament = material used in 3D printing



Question 5a (1 mark)

Given that the density of the filament is  $1.25 \text{ g/cm}^3$ . **Determine** the mass of one phone case in grams.

One mobile phone case



Volume of one case  $29 \text{ cm}^3$



Question 5b (2 marks)

Hence, **determine** the number of phone cases that can be printed from one spool of filament.

- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☒ 4 (12 marks) ▾
- ☐ 5 (10 marks) ▴
- Question 5a
- Question 5b
- Question 5c
- Question 5d
- Question 5e
- Question 5f
- ☐ 6 (22 marks) ▾
- ☐ 7 (32 marks) ▾



Scroll down to continue





Eleven phone cases are printed by Printer A. The time taken to print each case is recorded in the table below. Time is recorded in minutes, correct to 1 decimal place.

### Printer A

Time taken to print one phone case (minutes)										
18.3	18.5	19.1	19.8	19.8	19.9	20.3	20.4	20.7	20.8	21.1



### Question 5c (2 marks)

**Show that** the mean time taken to print one phone case is 19.9 minutes, correct to 1 decimal place.

**B**

*I*

↶

↷

U

$x_2$

$x^2$

$\frac{1}{2}$

$\frac{3}{4}$

$\frac{5}{6}$

$\Omega$

$\Sigma$

Styles

▼

📱

⬆

- 1 (9 marks) ▼
- 2 (7 marks) ▼
- 3 (8 marks) ▼
- 4 (12 marks) ▼
- 5 (10 marks) ▲
- Question 5a
- Question 5b
- Question 5c
- Question 5d
- Question 5e
- Question 5f
- 6 (22 marks) ▼
- 7 (32 marks) ▼



Scroll down to continue



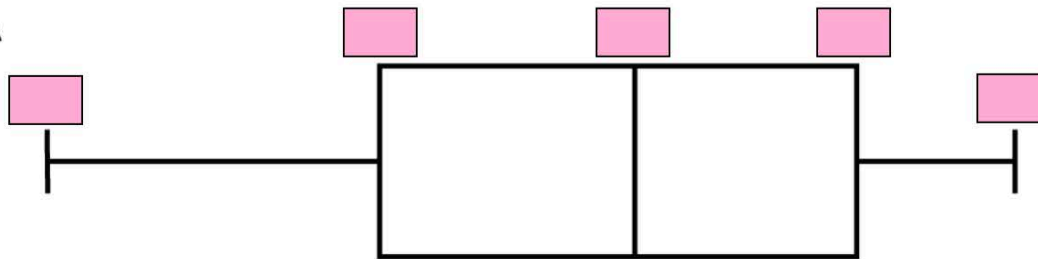


### Question 5d (3 marks)

The box-and-whisker plots represent the time taken by Printer A and Printer B to print 11 phone cases.

**Label** the box-and-whisker plot for Printer A.

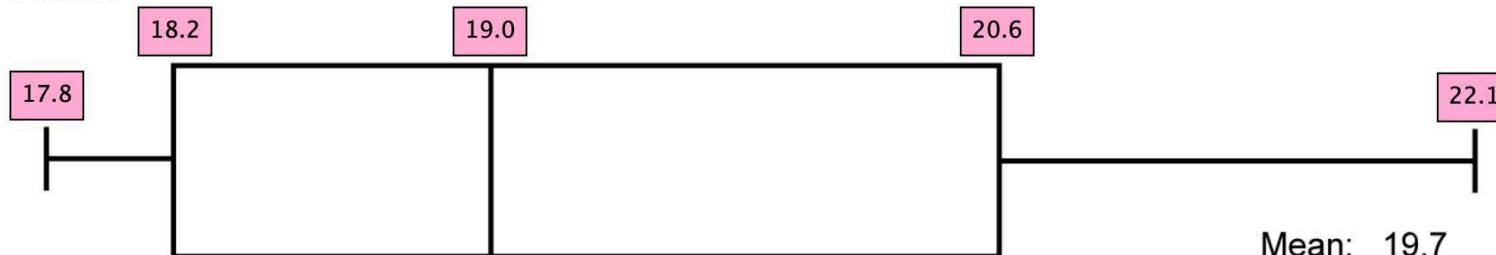
**Printer A**



Mean: 19.9

Mode:  

**Printer B**



Mean: 19.7

Mode: 20.6

- ☒ 1 (9 marks) ▼
- ☒ 2 (7 marks) ▼
- ☐ 3 (8 marks) ▼
- ☒ 4 (12 marks) ▼
- ☐ 5 (10 marks) ▲
- Question 5a
- Question 5b
- Question 5c
- Question 5d
- Question 5e
- Question 5f
- ☐ 6 (22 marks) ▼
- ☐ 7 (32 marks) ▼





### Question 5e (1 mark)

**Identify** one valid reason why Printer A might be considered better than Printer B.

**B**

*I*

↶

↷

U

$x_2$

$x^2$

$\frac{1}{2}$

$\frac{3}{4}$

$\frac{5}{6}$

$\Omega$

$\Sigma$

Styles



### Question 5f (1 mark)

**Identify** one valid reason why Printer B might be considered better than Printer A.

**B**

*I*

↶

↷

U

$x_2$

$x^2$

$\frac{1}{2}$

$\frac{3}{4}$

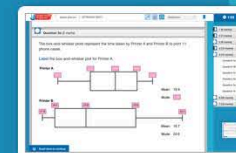
$\frac{5}{6}$

$\Omega$

$\Sigma$

Styles

- 1 (9 marks) ▾
- 2 (7 marks) ▾
- 3 (8 marks) ▾
- 4 (12 marks) ▾
- 5 (10 marks) ▴
- Question 5a
- Question 5b
- Question 5c
- Question 5d
- Question 5e
- Question 5f
- 6 (22 marks) ▾
- 7 (32 marks) ▾



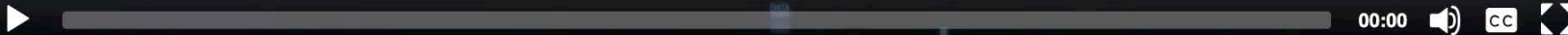


## Question 6 (22 marks)



Video

Script



- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☒ 4 (12 marks) ▾
- ☒ 5 (10 marks) ▾
- ☐ 6 (22 marks) ▴
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☐ 7 (32 marks) ▾



Scroll down to continue



## Question 6 (22 marks)



Video

Script

Machine learning is an application of artificial intelligence (AI) that provides systems the ability to automatically learn and improve from experience without being explicitly programmed.

These days machine learning technology is used in many aspects of our lives, including the fingerprint recognition and face recognition used to unlock smartphones.

The process of learning begins by multiple observations of an object, this helps a system to identify patterns in that object and therefore make better decisions in the future.

The primary aim is to allow the computers to learn automatically without human intervention or assistance and to adjust their actions accordingly.

There are different methods for machine learning: Eigenface, Fisherface and Local Binary Patterns Histogram (LBPH).

All methods of machine learning require multiple observations of the object. For example, in face recognition the programme will take many 'facial observations' in order to learn the features of the face to improve the success rate of face recognition.

In this question, you will explore the success rate for different methods of face recognition.

- ☒ 1 (9 marks)
- ☒ 2 (7 marks)
- ☒ 3 (8 marks)
- ☒ 4 (12 marks)
- ☒ 5 (10 marks)
- ☒ 6 (22 marks)
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☒ 7 (32 marks)



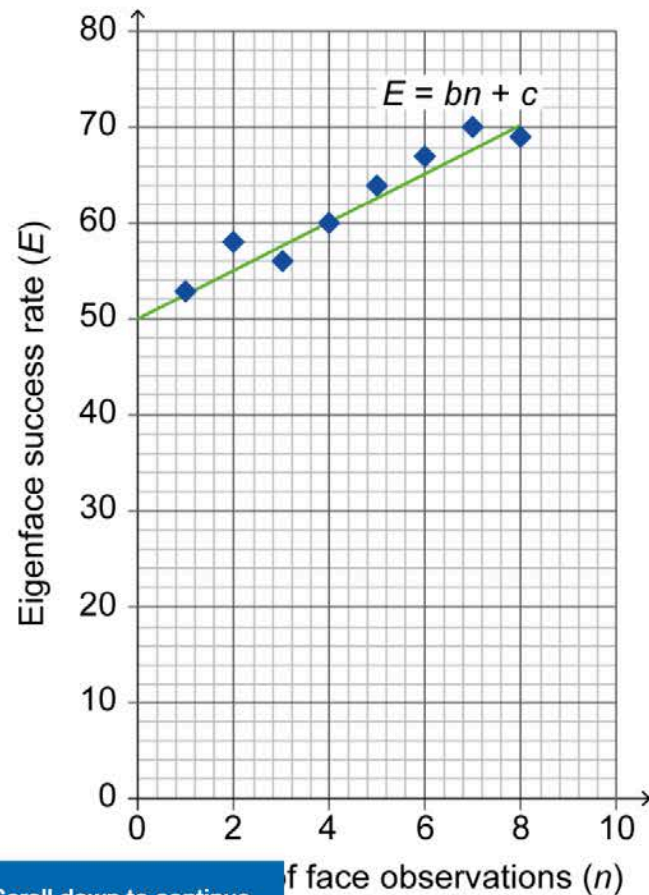
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**Question 6a** (2 marks)

The graph below shows data of the Eigenface method.



$E$  is the success rate (%) of the Eigenface method

$n$  is the number of face observations recorded per person.

**Determine** the values of  $b$  and  $c$ .

B

I

←

→

U

$x_2$

$x^n$

$\frac{1}{2}$

$\frac{1}{n}$

$\frac{1}{n^2}$

$\Omega$

$\Sigma$

Styles

- 1 (9 marks) ▾
- 2 (7 marks) ▾
- 3 (8 marks) ▾
- 4 (12 marks) ▾
- 5 (10 marks) ▾
- 6 (22 marks) ▴
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- 7 (32 marks) ▾



The Fisherface method can be modelled using the quadratic equation

$$F = -1.5(n - 8)^2 + 96; 0 < n \leq 8, \text{ where}$$

$F$  is the success rate (%) of the Fisherface method

$n$  is the number of face observations recorded per person.



### Question 6b (1 mark)

**Write down** the highest success rate ( $F$  max) and the corresponding value of  $n$ .

$F$  max

$n$



### Question 6c (5 marks)

**Find** the value of  $n$  at which the Fisherface method has the same success rate as the Eigenface method.

**B**

***I***

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↷

U

$\times_2$

$\times^2$

$\frac{\square}{\square}$

$\frac{\square}{\square}$

$\Omega$

$\Sigma$

Styles

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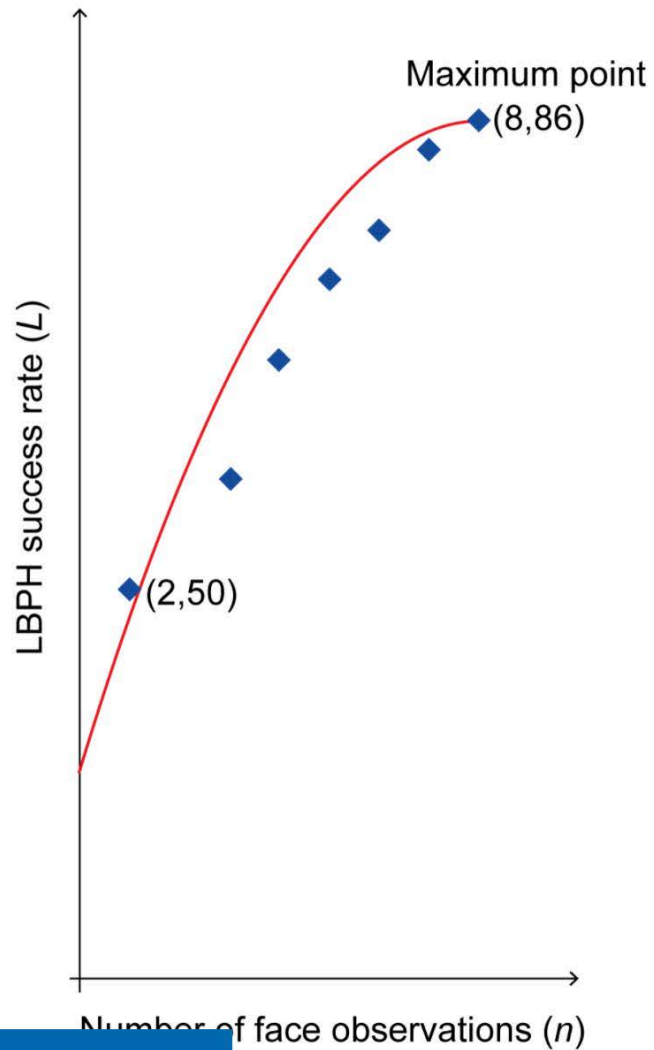
- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☒ 4 (12 marks) ▾
- ☒ 5 (10 marks) ▾
- ☐ 6 (22 marks) ▴
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☐ 7 (32 marks) ▾



Scroll down to continue



The graph below shows data of the Local Binary Patterns Histogram (LBPH) method.



Using the data in the graph, **find** a quadratic equation that models the LBPH method ( $L$ ) in terms of  $n$ .

Rich text editor interface with formatting options (Bold, Italic, Underline, etc.) and a large text area for input.



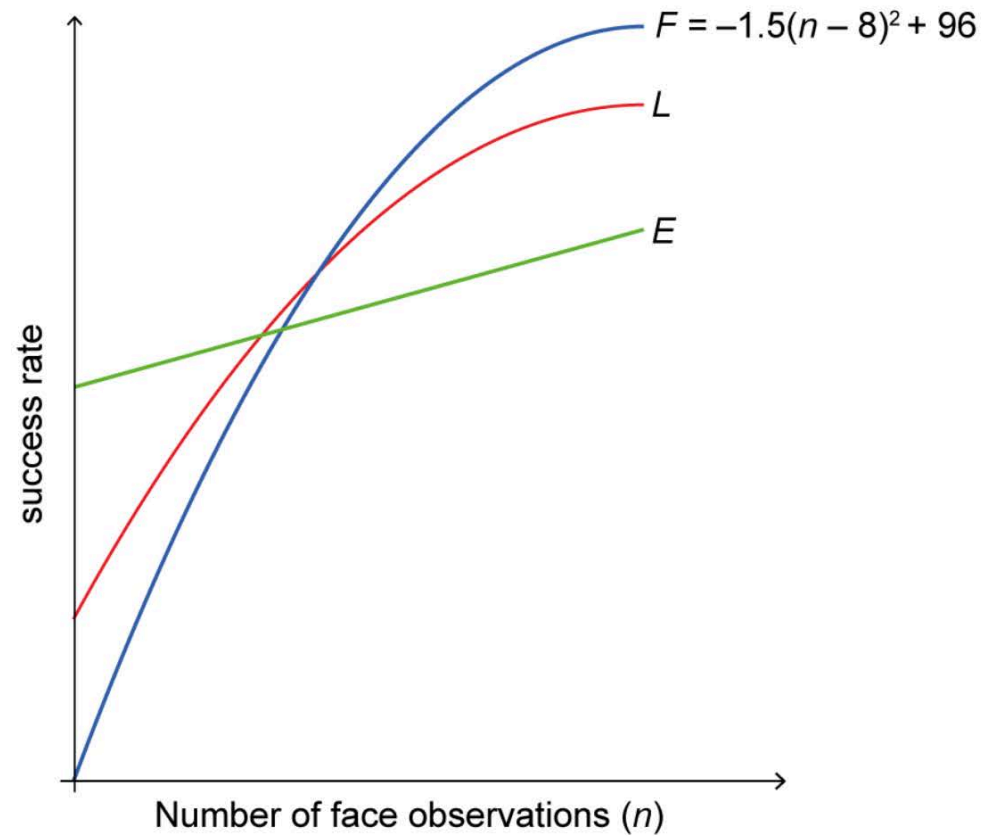
- ☐ 1 (9 marks) ▾
- ☐ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☐ 4 (12 marks) ▾
- ☐ 5 (10 marks) ▾
- ☐ 6 (22 marks) ▴
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☐ 7 (32 marks) ▾





Question 6e (10 marks)

The graph below shows the models for the three methods.




- ☐ 1 (9 marks) ▾
- ☐ 2 (7 marks) ▾
- ☐ 3 (8 marks) ▾
- ☐ 4 (12 marks) ▾
- ☐ 5 (10 marks) ▾
- ☐ 6 (22 marks) ▴
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☒ 7 (32 marks) ▾



Scroll down to continue

methods in order to



The factor:


  
Number of face observations ( $n$ )








**Analyse** the three methods in order to choose the best method. In your answer you should:

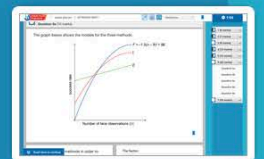
- identify the factor that affects the percentage success rate
- make calculations for the point of intersection between the FisherFace (F) and LBPH (L) methods
- comment on the accuracy of your results
- justify your choice for the best method.

The factor:

**B** *I*   U  $\times_2$   $\times^2$   $\equiv$   $\equiv$   $\Omega$   $\Sigma$

Styles 

- ☐ 1 (9 marks) 
- ☐ 2 (7 marks) 
- ☐ 3 (8 marks) 
- ☐ 4 (12 marks) 
- ☐ 5 (10 marks) 
- ☐ 6 (22 marks) 
- Question 6a
- Question 6b
- Question 6c
- Question 6d
- Question 6e
- ☒ 7 (32 marks) 





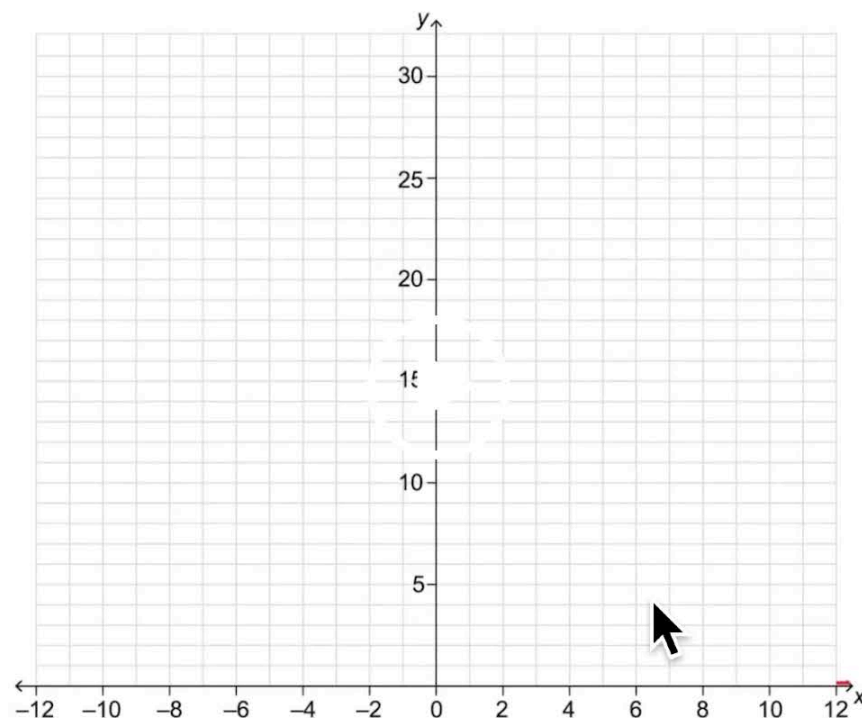
## Question 7 (32 marks)



Investigate the relationship between the number of squares inside a rectangle between two exponential functions.

An exponential function and its reflection on the y-axis are shown.

Stage 0



- 1 (9 marks) ▾
- 2 (7 marks) ▾
- 3 (8 marks) ▾
- 4 (12 marks) ▾
- 5 (10 marks) ▾
- 6 (22 marks) ▾
- 7 (32 marks) ▴

Question 7a

Question 7b

Question 7c

Question 7d

Question 7e

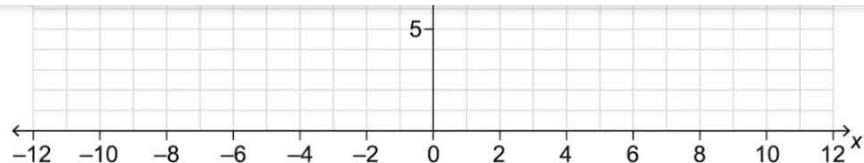
Question 7f



00:00



Scroll down to continue



Drag the slider to see how the squares are added.

Stage 1

$$g(x) = \left(\frac{1}{2}\right)^x$$

$$f(x) = 2^x$$



- ☒ 1 (9 marks) ▾
- ☒ 2 (7 marks) ▾
- ☒ 3 (8 marks) ▾
- ☒ 4 (12 marks) ▾
- ☒ 5 (10 marks) ▾
- ☒ 6 (22 marks) ▾
- ☒ 7 (32 marks) ▴

Question 7a

Question 7b

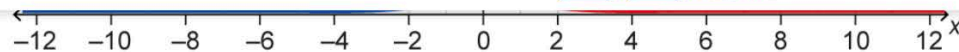
Question 7c

Question 7d

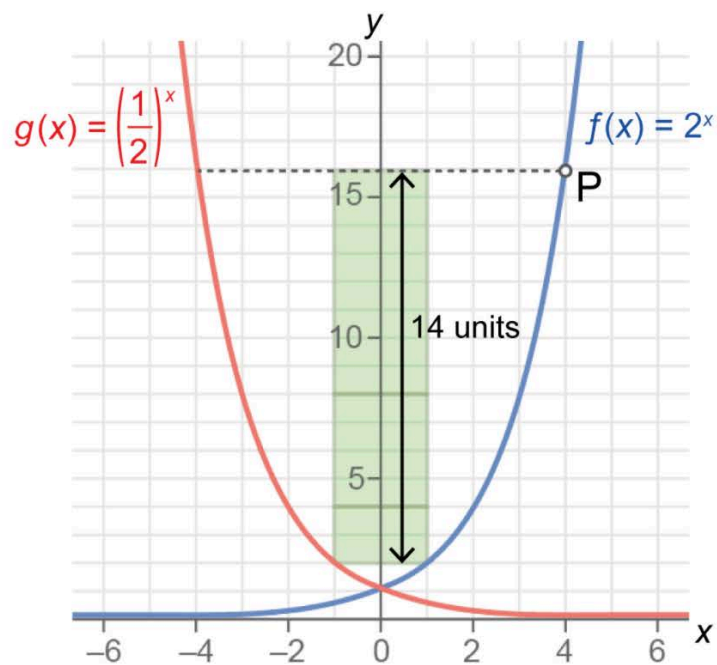
Question 7e

Question 7f





### Question 7a (2 marks)



In stage 3, **show that** the height of the rectangle is 14 units. In your workings you must use the laws of exponents.

**B** **I**   $x_2$   $x^2$   $\frac{1}{x}$   $\frac{1}{x^2}$   $\Omega$   $\Sigma$

Styles



- ☒ 1 (9 marks)
- ☒ 2 (7 marks)
- ☐ 3 (8 marks)
- ☒ 4 (12 marks)
- ☒ 5 (10 marks)
- ☐ 6 (22 marks)
- ☐ 7 (32 marks)

Question 7a

Question 7b

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Scroll down to continue

(mark)



### Question 7c (2 marks)



-6 -4 -2 0 2 4 6 x



### Question 7b (1 mark)

**Write down** the missing values in the table.



Stage ( $n$ )	Number of new squares ( $S$ )
1	4
2	8
3	16
4	32
5	
6	


Reset



### Question 7c (2 marks)

**Describe** in words **two** patterns for  $S$ .

**B** *I*  
U  $\times_2$   $\times^2$ 
 $\frac{1}{2}$   $\frac{1}{3}$   $\frac{1}{n}$ 
 $\Omega$   $\Sigma$

Styles 



### Question 7d (2 marks)

**Determine** a general rule for  $S$  in terms of  $n$ .

- 1 (9 marks) ▾
- 2 (7 marks) ▾
- 3 (8 marks) ▾
- 4 (12 marks) ▾
- 5 (10 marks) ▾
- 6 (22 marks) ▾
- 7 (32 marks) ▴

Question 7a

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### Question 7b (1 mark)

**Write down** the missing values in the table.

Stage ( $n$ )	Number of new squares ( $S$ )
1	4
2	8
3	16
4	32
5	
6	

Reset



### Question 7d (2 marks)

**Determine** a general rule for  $S$  in terms of  $n$ .

B I

↶ ↷

U

$\times_2$

$\times^2$

$\frac{1}{2}$

$\frac{1}{3}$

$\frac{1}{n}$

$\Omega$

$\Sigma$

Styles

📱



- 1 (9 marks) ▼
- 2 (7 marks) ▼
- 3 (8 marks) ▼
- 4 (12 marks) ▼
- 5 (10 marks) ▼
- 6 (22 marks) ▼
- 7 (32 marks) ▲

Question 7a

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### Question 7e (3 marks)





### Question 7b (1 mark)

**Write down** the missing values in the table.

Stage ( $n$ )	Number of new squares ( $S$ )
1	4
2	8
3	16
4	32
5	
6	

Reset



### Question 7e (3 marks)

**Verify** your general rule for  $S$ .

B

I

←

→

U

$x_2$

$x^2$

$\frac{1}{2}$

$\frac{3}{4}$

$\Omega$

$\Sigma$

Styles



- 1 (9 marks)
- 2 (7 marks)
- 3 (8 marks)
- 4 (12 marks)
- 5 (10 marks)
- 6 (22 marks)
- 7 (32 marks)

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(marks)



Question 7f (22 marks)

**Investigate** the values in the table to find a relationship for the total number of squares (T) in terms of  $n$ . In your answer you should:

- predict more values and record these in the table
- describe in words **two** patterns for column T
- determine a general rule for T in terms of  $n$
- test your general rule for T
- verify and justify your general rule for T
- ensure that you communicate all your working appropriately.

Stage ( $n$ )	Number of new squares (S)	Total number of squares (T)	
1	4	4	
2	8	12	
3	16	28	
4	32	60	
5			
6			

Reset

B I

↶ ↷

U  $\times_2$   $\times^2$

$\frac{1}{x}$   $\frac{1}{x^2}$

$\Omega$   $\Sigma$

Styles

📱

- 1 (9 marks)
- 2 (7 marks)
- 3 (8 marks)
- 4 (12 marks)
- 5 (10 marks)
- 6 (22 marks)
- 7 (32 marks)

Question 7a

Question 7b

Question 7c

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